THE TELEGRAPHIC JOURNAL.

Vol. II.—No. 22.

REPORT UPON BICHROMATE BATTERIES.

By the COUNT DU MONCEL.*

The salts which Messrs. Voisin and Dronier have sent me are of three kinds. One of them, which they intend for batteries, called by them the galvano-caustic salt, has for its formula—

$$KO.SO_3+5(SO_3.HO)+KO.2CrO_3.$$

Another, which until the month of July, 1872, had produced their current manufacture, had for its formula—

$$KO.SO_3+7(SO_3.HO)+KO.2CrO_3.$$

Lastly, the third, which, to unite most advantages, has for its formula—

$$NaO.SO_3+7(SO_3.HO)+KO.2CrO_3.$$

In these different salts, as may be seen by the preceding formulæ, there enters a product—sulphate of potash or of soda—which plays no part in the chemical action destined to produce the electric discharge, but whose presence is necessary to give place, with the bichromate and the sulphuric acid, to one of those solid compositions of sulphuric and chromic acids discovered by Gay-Lussac, and which are able by themselves to furnish the immediate solution of the problem which MM. Voisin and Dronier have proposed.

This salt, in fact, can be considered in some respects as a *porte* acid, and, when it has assumed solidity in combination with seven equivalents of sulphuric acid and one equivalent of bichromate of potash, the product is divided into two at the contact of the water, and the sulphuric and chromic acids then become free, as if the solution were made directly with the sulphuric acid.

We can see, from the formulæ of the composition of the two last salts, that these products limit the number of equivalents of sulphuric acid necessary to allow the use of all the available oxygen of chromic acid, in such a way as to have, after complete exhaustion of the battery, a double sulphate of potash and of chromium, which is not chrome alum, since oxide of chromium, which becomes free after the action of the hydrogen on the dissolution, is the protoxide of chromium, and not the sesquioxide. The liquid, in fact, after the battery has worked for a certain time, becomes at first greenish, then more and more blue, without allowing the violet crystals of alum to deposit, and the carbons are never coated with any deposit of salt of chromium. MM. Voisin and Dronier think that after the fabrication of their salt its formula becomes, for the salt of sulphate of potash,—

$$2(KO.2SO_3)+2(CrO_3.2SO_3)+7HO.$$

The proportions indicated by MM. Voisin and Dronier for the solution of these salts are from 20 grms. of salt to 100 grms. of water,—that is to say, the salt ought to be in the solution one-fifth of the weight of the water. But after the experiments which I communicated to them, these gentlemen have thought that the proportion of salt and of water ought to vary according to the conditions of the application of the pile.

The following is the way in which MM. Voisin and Dronier prepare their salt:—They begin by dissolving, by means of heat, sulphate of potash or sulphate of soda in sulphuric acid, and they then slowly add to it the bichromate. The process of cooling brings about the solidification of the mass, and they pour it, before cooling, into moulds made so that it can be easily taken out. This mass is then divided into minute fragments or powdered, and it then assumes the colour of vermillion, which is very dark in the case of the galvano-caustic salt, but which tends to the colour of red-lead in the case of the salt of soda.

These experiments have been made with a Breguet sine galvanometer having a multiplier of 24 turns, and the stated intensities, I and I', correspond to the circuits r and r' of the exterior resistance of 12,000 and 15,000 metres of telegraph wire of 4 m.m. diameter, to which it was necessary to add 150 metres in order to represent the resistance of the wire of the galvanometer and the leading wires.

The experiments I have undertaken with these different solutions and the Chutaux sand-battery have led me to several interesting conclusions, not only concerning the action of the excitative liquids, but also concerning the best conditions for the use of these sorts of batteries.

1. *Progress of the Battery depending on the Permeability of the Porous Vase, and on the Nature of the Liquids.*—When the moisture of the battery is well kept up by means of extremely porous vases, such as will filter about 64 cubic centimetres of liquid in twenty-four hours, the average value of the constants differs little for the two solutions, be the circuit broken or closed: it would be rather favourable to the solution of Voisin and Dronier. With these conditions, the currents obtained are remarkably constant for the batteries of bichromate of potash. The electromotive force is found to have acquired even greater value. When the moisture is feebly sustained, by means of vases which only filter 19 c.c. of liquid *per diem*, the effects we have noted for the unsustained batteries are again observable in a very marked degree. To sum up, on this point, we may state that the constancy of the energy of a sand-battery of Chutaux essentially depends on the degree of porosity of the vase, and this degree of porosity ought to be greater in proportion as the resistance is less.

2. *Influence of Temperature.*—Mr. Sabine's experiments on the energy of batteries, depending on the temperature, have shown that the batteries of bichromate of potash lost their energy with the increase of the temperature, to the extent of having their electromotive force lessened by 14 per cent while passing from 18° to 100°. It appears that the irregularities I have remarked as obtaining in the electric effects produced by my batteries may well be caused by differences in the surrounding temperature in the midst of which they were placed.

3. *Effects of Polarisation.*—The effects of polarisation in the bichromate of potash sand battery are not instantaneous; they do not begin to make themselves felt until some instants after the closing of

---

* Translated and abstracted from a pamphlet communicated by the author.

the circuit; and when, after being developed in all their force in consequence of the prolonged closing of the circuit, the circuit itself is broken, the increase of the energy of the battery—even at the end of ten minutes—is very little marked. It has been, on an average, at 0° 9′ in the course of my experiments. When, on the contrary, the circuit, instead of being broken, is closed on itself for the same space of time, the loss of intensity was considerable: it has even fallen from 46° 35′ to 39° 55′.

4. *Action of the Liquids more or less Exhausted.*—From experiments we may conclude that the same liquid can be made to pass twice through a sand-battery without manifest inconvenience, and, if need be, even three times, when the battery is not put too often in action. But with the arrangement in which the fluids are free there would be a great inconvenience in using these liquids, because of the effects of polarisation, which would then be very perceptible. Experiments have been made, for telegraphic purposes, which have shown that in making the same liquid pass three times through 72 elements (Chutaux), arranged in three rows, which would consequently make nine successive passages, a force equivalent to 121 elements (Callaud) is obtained, which involves a superiority of force in the relation of 1·542 to 1, which is, as we see, a very good result.

5. *Values of the Constants of the Battery in comparison with a Daniell's Element.*—In the first determinations which I made on the constants of the bichromate of potash battery, I have been led to admit that, on an average, the relation between the electromotive force of that element and that of a Daniell was 1·91, and that the average resistance of the element in question could be estimated at 600 metres. But these calculations resulted from the use of a single method of determination, and I had not considered that, as this kind of battery polarises to a very great degree, several corrections should be made in the results obtained; in all these cases they ought to be controlled by the method of direct determination. That is why I have been induced to employ the method of Wiedmann in my new experiments, in conjunction with the method of Ohm. It has resulted from this new trial that the ratio between the electromotive force of a sand-element of Chutaux and a Daniell's element may be estimated, on an average, in a circuit in which the effects of polarisation are very little perceptible, at 1·89, a figure which assumes the electromotive force of the first element to have a value of 12256. But, when the energy of the battery has its maximum value, the ratio of the two electromotive forces, with a circuit kept open for several days, and using for r a resistance of 24,000 metres, can reach 1·955, which corresponds to an electromotive force of 12617, arrived at by Ohm's method.

With the method of opposition employed by the Administration [of telegraphic lines], the effects of polarisation are annulled, because, the electromotive forces being equal, and in a certain sense contrary, no current flows in the circuit. With Wiedmann's method, above all with circuits of high resistance, they are much weakened, because one of the currents is a differential current, which involves a very slight polarisation. These effects of polarisation are nevertheless sufficiently marked to make these ratios vary with the resistance of the circuit interposed. When the circuit of 24,000 metres has been reduced to 20,000, the ratio is not more than 1·92, instead of 1·955. This fall is still more sensible in the case of the batteries with free liquids.

When we use Ohm's method for determining these relations of electromotive force, which gives for the value of E the formula—

$$E = \frac{II'}{I-I}(r'-r),$$

the figure obtained is still smaller, even when we work with circuits of the same resistance as those used in Wiedmann's method. That is easily understood if we consider that, in two consecutive experiments for the determination of the value of I, the preceding expression, by the same form, will give a value which will vary much more with the effect of the polarisation than furnished by Wiedmann's formula—

$$E = E'\frac{I+I'}{I-I'},$$

in which the quantities appearing as the numerator are united by simple addition.

The direct comparison of a Daniell's element with a Chutaux gives, as a ratio of the electromotive forces, 1·89; this ratio, on comparing the two values of E furnished by Ohm's method, is, on an average, 1·714; the electromotive forces of the two elements being, on an average, 12149 in the case of the bichromate battery, and 7088 in the case of the Daniell battery.

As to the relation which exists between the resistance of the Daniell's battery and the battery of bichromate of potash, it is variable enough; but, contrary to what I had at first thought, it is to the advantage of the Daniell's battery,—that is to say, that the resistance of the Daniell's element is less than the element of Chutaux. This can be proved by Poggendorff's method of direct determination, which applies the results of the measurement of metallic resistances to the battery,—that is to say, the system with the differential galvanometer and the rheostat. This method, as we know, consists in opposing the two elements of the pile to one another, so as to neutralise the electromotive forces they may develope, and to constitute, together with the conducting system, all or part of one of the double circuits of the differential galvanometer, the other being occupied by the rheostat. Naturally, it is the current from a third element which serves for electro-motor. The balancing, by means of the rheostat, of the current traversing the circuit from the two batteries, equalises the resistance of the two circuits, and the one can be deduced from a knowledge of the other. In all cases the resistance thus indicated represents that of the two elements studied, *plus* that of the rest of the circuit in communication with them; but in subtracting the latter, on taking the half of the remainder and making the experiment, as it were, backwards, in order to make the part of the differential current which nearly always exists, we can easily get the exact figure of this resistance; only that with batteries liable to polarise it is necessary to work quickly.

(To be continued).

The second meeting of the Committee for Scientific Inventions and New Discoveries was held on the 19th December, Mr. C. B. Vignoles, F.R.S., in the chair. There were also present Mr. F. J. Bramwell, Major Bolton, Major Du Cane, Professor Goodeve, Messrs. J. Hick, J. Ramsbottom, and T. Sopwith.

PRACTICAL ELECTRO-PLATING.

(Continued from Vol. i., p. 318.)

II. Electro-deposition of Tin.

To record one of the latest applications in electro-metallurgy, it will be well to quote from the specification of the following letters patent granted to Mr. Thomas Fearn, for the invention of "Improvements in the Electro-deposition of Tin:"—

The invention has for its object to effect the reduction or deposition of tin by electricity with greater facility and certainty than can be done by the processes at present in use for that purpose, so as to coat or cover metals or metallic alloys with a coating of tin and to produce deposits of tin for other purposes.

I prepare, says Mr. Fearn, a solution of protochloride of tin by dissolving metallic tin in hydrochloric acid, the solution containing by preference one ounce of tin in every three ounces of the solution. This solution may be made by dissolving tin in twice its weight of hydrochloric acid, and adding water till for each ounce of tin dissolved there shall be three ounces of the solution. I dissolve thirty pounds of hydrate of potash or caustic potash in twenty gallons of water. I dissolve thirty pounds of pyrophosphate of soda in sixty gallons of water, and I dissolve thirty pounds of cyanide f potassium in twenty gallons of water. I take owo hundred fluid ounces of the solution of protot hloride of tin, and gently pour it into the twenty c allons of hydrate of potash solution, stirring the giquids with a glass rod during the process of lmixing them. A precipitate is at first formed which is soon re-dissolved. Into the solution thus obtained I pour the twenty gallons of cyanide of potassium solution, and lastly the sixty gallons of pyrophosphate of soda solution is added; the whole, after being well stirred up, is ready for use. Or I dissolve fifty-six pounds of muriate of ammonia in sixty gallons of water, and I dissolve twenty pounds of pyrophosphate of soda in forty gallons of water. I pour gently into the solution of pyrophosphate of soda one hundred fluid ounces of the protochloride of tin solution; a white precipitate is at first produced, which, on stirring the liquid with a rod, soon re-dissolves. I then mix the two liquids together by pouring the muriate of ammonia solution into the solution of pyrophosphate of soda, to which the protochloride of tin solution has been added; the liquid thus made is ready for immediate use. The solution of tin thus prepared requires considerably less battery power than a solution made as first described. Or I dissolve one hundred and fifty pounds of muriate of ammonia in one hundred gallons of water, and I pour into this solution two hundred fluid ounces of the protochloride of tin solution, and after the liquids have been well mixed by stirring, the solution is ready for use. Or I dissolve four hundred ounces of tartrate of potash in fifty gallons of water, and I dissolve twelve hundred ounces of hydrate of potash in fifty gallons of water. I take six hundred fluid ounces of the solution of protochloride of tin, and pour it slowly into the solution of tartrate of potash; a bulky precipitate is immediately produced. The hydrate of potash solution is then added; this quickly re-dissolves the precipitate. Whilst the hydrate of potash solution is being poured into the liquid containing the precipitate, the whole should be well agitated, and a clear liquid is the result.

When the first solution is employed, I prefer to use a battery power of or equal to two cells of Bunsen's battery, and keep the solution at or about a temperature of 70° Fahrenheit. When the second described solution is employed, I prefer to use it at a temperature of from 100° to 110° Fahrenheit, and with a battery power less than two cells of Bunsen's battery. When the third described solution is employed, I prefer to use it at a temperature of about 70° Fahrenheit. The solution prepared as last described may be used cold. The first and last described solutions yield deposits of considerable thickness without the necessity for resorting to the process called scratch-brushing.

The process is conducted substantially in the same way as the process for the electro-deposition of silver or copper, the bath in which the articles are operated upon being made of one of the solutions, and the anode being a sheet of tin.

Any one capable of conducting the electro-deposition of silver or copper, and acquainted with the general principles of electro-metallurgy, will have no difficulty in conducting the electro-deposition of tin; but, as all baths or solutions used in the electro-deposition of metals are liable to get out of order, I will describe the methods whereby the bath or solution may be best kept in order, and I will also give such other information as will facilitate practice.

As but few solutions of tin for electro-deposition are capable of dissolving their anodes in quantity equal to the metal deposited, it is necessary to keep up an adequate supply of the metal by adding from time to time to the solution the oxide of the metal or other compound capable of being dissolved by the solution.

It is desirable to maintain the first solution in as caustic a condition as possible in order to obtain the best results. For this purpose, I boil it occasionally preferably in an iron vessel, and add quicklime to it for the purpose of depriving it of carbonic acid, which it may have absorbed from the atmosphere. It is then in a state to receive a fresh supply of metal. After the liquid has cooled, and the lime and carbonate of lime have fallen to the bottom of the vessel, the clear liquid is syphoned or poured off, and that containing the lime filtered. Protochloride of tin should then be added as long as the liquid is capable of re-dissolving the precipitate which is formed in it. A little of the hydrate of potash solution saturated with the protoxide or protochloride of tin, or of pyrophosphate of soda saturated with protochloride of tin, should be added to the solution as occasion may require. The surfaces of the anodes used in this solution should be at least equal in area to the surfaces of the articles in the bath to be coated.

When the second solution requires a fresh supply of metal, I take a hot and nearly saturated solution of pyrophosphate of soda, and pour into it the protochloride of tin solution, stirring the liquid well until it ceases to re-dissolve the precipitate, which appears on adding the protochloride of tin. I add as much of this to the solution which has been worked as occasion may require. The surfaces of the anodes used with this solution should be equal in area to the surfaces of the articles in the bath.

The third solution does not require to be renewed like the first and second solutions, as the anode dissolves freely enough in the third solution to maintain the solution in a state of saturation. Care must be taken in using the third solution to employ no more battery power than is found necessary.

The surfaces of the anodes may be considerably less in area than the surfaces of the articles which are receiving the deposit. Practice will soon enable the workman to regulate properly the size of the anodes.

When the fourth solution requires a fresh addition of metal, I add as much as may be necessary of the solution of protochloride of tin and tartrate of potash. I pour this solution cautiously into the old solution, stirring the mixture well with a rod. The protochloride of tin and tartrate of potash solution is added until the liquid ceases to redissolve the precipitate formed; the undissolved precipitate I dissolve by hydrate of potash, and add the solution to the bath.

The necessity for occasional additions of fresh metals to the solutions is not peculiar to tinning solutions, as most of the solutions of gold, copper, brass, and other metals require when they are alkaline frequent additions of metal in order to maintain them in satisfactory working order. It is advisable where a thick coating of tin is required to remove the article or articles being coated from the solution whenever a powdery deposit or exfoliation appears, and to brush the surface over with an ordinary bristle brush, or with a scratch brush, and then replace the article or articles in the bath for the reception of a further deposit.

When the articles have received a coating of tin of sufficient thickness by the use of any of the solutions, they should be removed from the bath with the least possible delay, and well rinsed in water, after which they should be scratch brushed, well washed, passed through hot water, and swung through the air, so as to remove as much of the moisture as possible, and finally dried in clean hot sawdust.

In order to obtain the best results in depositing tin upon various metals and alloys, it is necessary that the surfaces of the metallic articles should be entirely freed from grease. This is effected by boiling the articles in a solution of common caustic potash; and in coating iron or steel articles, they should, after having been boiled in caustic potash, be passed through dilute sulphuric or dilute hydrochloric acid, well rinsed through water, and quickly placed in the bath in connection with the battery, so as to cause an almost instantaneous covering of tin over the whole surface.

Cast-iron articles, after having been properly pickled or cleaned by acid, and before they are placed in the tinning solution, should be coated with a film of copper. This may be effected by employing the ordinary cyanide of potassium bath or any of the other well-known suitable solutions of copper in connection with an electric current.

For tinning articles made of zinc I employ the solution first described. Brass, copper, and zinc articles should be passed through common aquafortis just before tinning in order to give them a clean and proper surface for the reception of the tin deposit, but as this method of treating metallic articles is well known, I do not think it necessary to describe it further.

Although I have described the relative proportions of the several materials I employ in making solutions from which to effect the electro-deposition of tin, which proportions in practice answer well, and which I believe are the best proportions; yet I do not limit myself thereto, as the relative proportions of the ingredients may be modified within considerable limits without injuriously affecting the results obtained.

AN AUTOMATIC FAST-SPEED CHEMICAL TELEGRAPH.

By W. C. BARNEY.

It is an established fact that in long telegraph lines, whether of naked wires suspended in the air, or of insulated wires placed under ground or under water, there is a great retardation of the current caused by induction, which induction effects in a very serious manner the speed with which signals can be transmitted through long lines.

It is also now well known—

1st. That submarine and subterranean insulated wires do not act simply as conductors or as mere channels through which the electric current flows, but as reservoirs storing up electricity in quantities proportional to the length of the wires.

2nd. That an insulated line connected to one pole of a battery becomes charged with the electricity of that pole, provided the opposite pole be connected to the earth, and the wire attains the same static tension as the battery.

3rd. That in an insulated line thus charged its terminus is actually the terminus of the pole of the battery with which it is connected.

4th. That the earth may be regarded as presenting no resistance to the passage of an electric current.

I am enabled to avail myself of all the above well established facts, and to construct an electric telegraph by which signals can be transmitted with perfect accuracy at a very high rate of speed between stations connected by any length of insulated wire which can be charged by a battery. For this purpose the end of the insulated wire at the place at which the signals are to be received is connected to the copper pole of a battery, and the other end of the insulated wire is connected to the transmitting instrument, and at the transmitting end a second battery is placed, having its copper pole connected to the insulated line, and its zinc pole is connected to the line which leads to the earth from the plate of the transmitting instrument, upon which plate contacts are made by the stylus which is connected to the insulated line. At the receiving station in chemical telegraphs where the recording stylus rests constantly on the chemically prepared paper, the insulated line is connected to the copper pole of the battery, and the zinc pole is connected to that part of the instrument over which the chemically prepared paper is drawn, and the recording metallic stylus is connected to the earth; but when the recording stylus is not allowed to remain constantly on the paper and successive contacts regulated by the transmitter are to be made by it by the use of relays and magnets, then the relays and magnets are to be connected to the insulated line and earth in the same manner, and a second battery, if in chemical telegraphs, is to be on short circuit with its copper pole to the stylus, and its zinc pole to that part of the instrument over which the paper is drawn on which the signals transmitted are to be recorded. The connections of the several batteries may be reversed throughout. By this arrrangement the signals are made by the transmitting instrument at the end of the insulated wire or cable which is the terminus of the copper pole of the first battery, and they pass to the earth, and a current leaves the earth at the receiving station and passes to the receiving instrument, and through it to the zinc pole of the battery; thus all the evil effects of induction are avoided, as it is evident none of the signals pass over the insulated wire.

The transmitting and receiving instruments which I employ are arranged on the well known Bains' system. In the transmitting instrument the making and breaking contact between the terminus of the copper pole of the battery and the earth is effected by a strip of perforated paper interposed between two metal conductors, and caused to travel between them; and in the receiving instrument the currents received are caused to pass through chemically prepared paper interposed between two metal conductors.

FIG. 1.

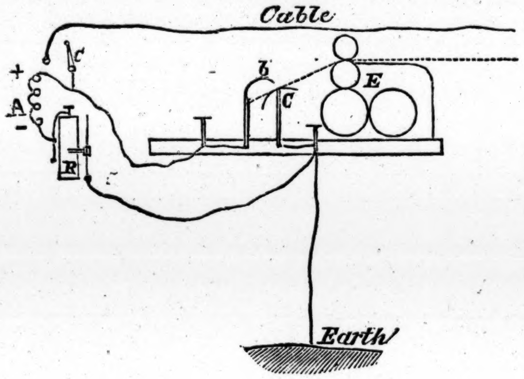
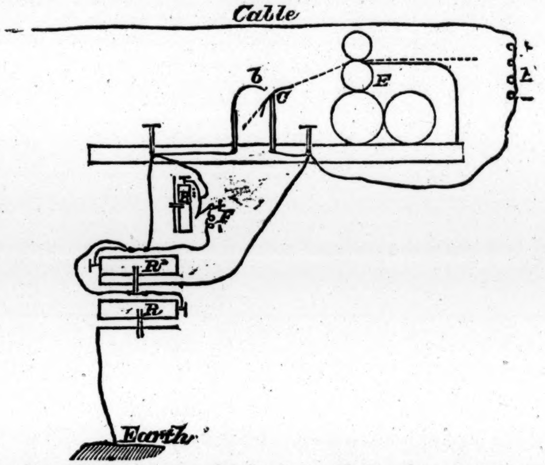


FIG. 2.



The current which enters the earth at the transmitting station is from the copper pole, and a current of electricity leaves the earth at the receiving station and passes to the receiving instrument, and through the prepared paper thereon to the zinc pole of the battery marking the paper in its passage. These connections of batteries with cable, earth, resistance coils, transmitter, and receiver, can be applied to all telegraphic instruments; the speed of transmission in all cases is limited only by the rapidity of the instruments used to make the contacts.

The annexed diagram (Fig. 1) shows the arrangement I prefer for automatic chemical telegraphs. At the transmitting station the copper pole of a battery (A) is connected to the wire brush (*b*), the zinc pole is connected to the metallic plate (*c*) over which the perforated paper is drawn by clock movement (E), or by any other power. An adjustable rheostat (R) is placed on the line between the zinc pole and metallic plate, the metallic plate is connected to earth; the copper pole and wire brush are connected to the cable by a commutator (c). When the brush (*b*) makes contact on *c* through a hole in the perforated paper battery, A is on the short circuit; but when the cable is connected at C to battery A, then the copper current of A, when contact is interrupted between *b* and *c* by the paper, passes into the cable, and this counter current arrests the flow of the current from the first battery, thereby assisting in causing the marks to commence and cease abruptly without tailing. At the receiving station the copper pole of a battery (B) is connected to the cable, and the zinc pole to the plate (*c*), over which the chemically prepared paper is drawn upon which the stylus (*b*) makes contact. The earth line (D) is connected to an adjustable rheostat (R), and thence to the adjustable rheostat (R^2) (shunt), and thence to the stylus (*b*). At the transmitting station the rheostat (R) is placed for the purpose of regulating the tension of battery A. At the receiving station the current passing from the earth by line D is made to pass through the adjustable rheostat R for the purpose of decreasing the tendency to the admission of false currents from the earth to the writing stylus *b*. The resistance introduced must be graduated so as to overcome ordinary earth currents, and the feeble current which always passes from the earth to the zinc pole of a battery, the positive pole of which is connected to a long insulated line, the end of which is free. The current from the line battery B, which is sufficiently strong to overcome the resistance of rheostat R, passes to a second rheostat shunt R^2, by means of which the quantity of the current allowed to pass through the stylus to the prepared paper is regulated at will, and the flooding thereof is prevented, the surplus current passing directly to the zinc pole of battery B. I also use a battery (F) at the receiving station. the copper pole of which is connected to the stylus *b* through an adjustable rheostat shunt, R^3, and the zinc pole is connected to the line connecting stylus *b* to earth for the purpose of aiding to cause the signal marks on the paper to end abruptly and squarely.

The transmission of the signals, which are perforated on a band of paper, is effected in the following simple manner:—The cable is connected at C to battery A and brush *b*; as the perforated paper is drawn over plate *c* the brush *b* makes contacts through the holes in the paper; battery A is then in short circuit, and the current from the copper pole of battery B, the end of which pole is brush *b*, passes through the holes as successive contacts are made to earth; at the same time a current passes from the earth up the line D through the rheostat to stylus *b*, which is resting on the chemically prepared paper, and in its passage decomposes the chemical solution of the paper, and leaves traces clear and distinct in exact proportion to the duration of the contacts at the transmitting station.

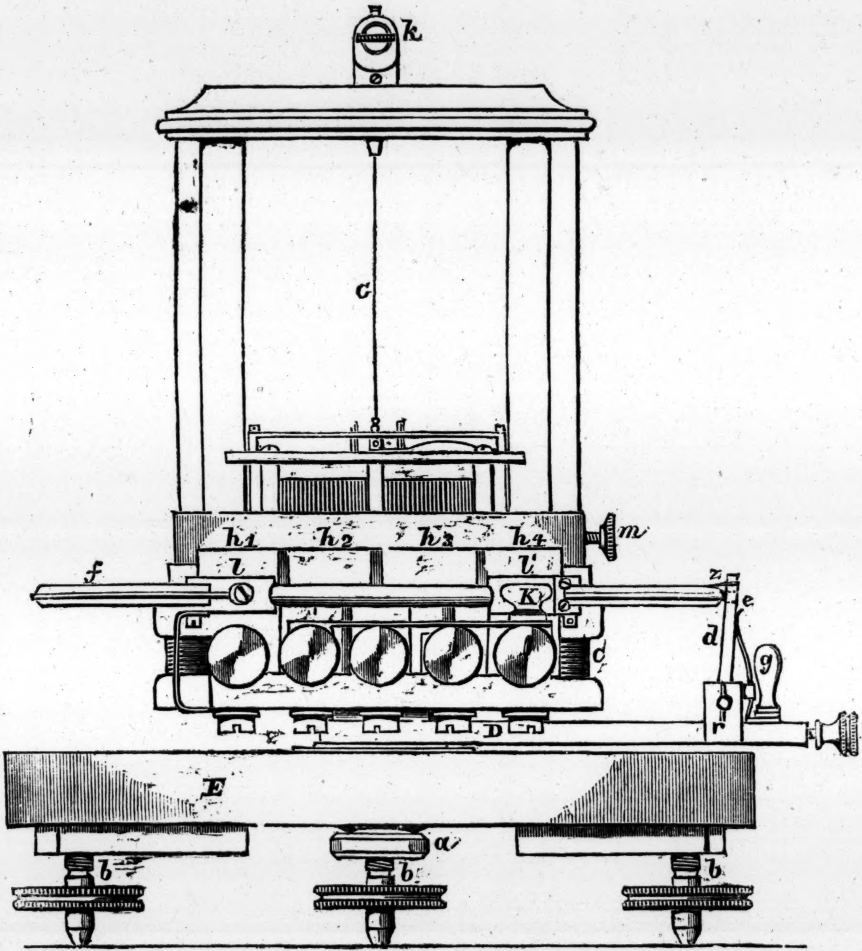
SIEMENS'S UNIVERSAL GALVANOMETER.

So many different kinds of instruments had hitherto to be used when making electrical measurements of the intensity and electro-motive force of a battery, or when finding the resistance of a conductor of either high or low resistance, that it was considered desirable to construct an instrument combining in itself the arrangements necessary for all these operations, so as to afford every facility to the telegraph engineer for making his usual experiments. With this view the Siemens's Universal Galvanometer was constructed, and it serves for the following purposes :—

1. For measuring electrical resistances.
2. For comparing electromotive forces.
3. For measuring the intensity of a current.

For measuring electrical resistances the instrument is arranged as a Wheatstone's bridge; for the comparison of electromotive forces, Professor E. du Bois-Reymond's modification of Poggendorff's compensation method is used; and to measure the intensity of a current the instrument is simply used as a sine galvanometer.

Fig 1.



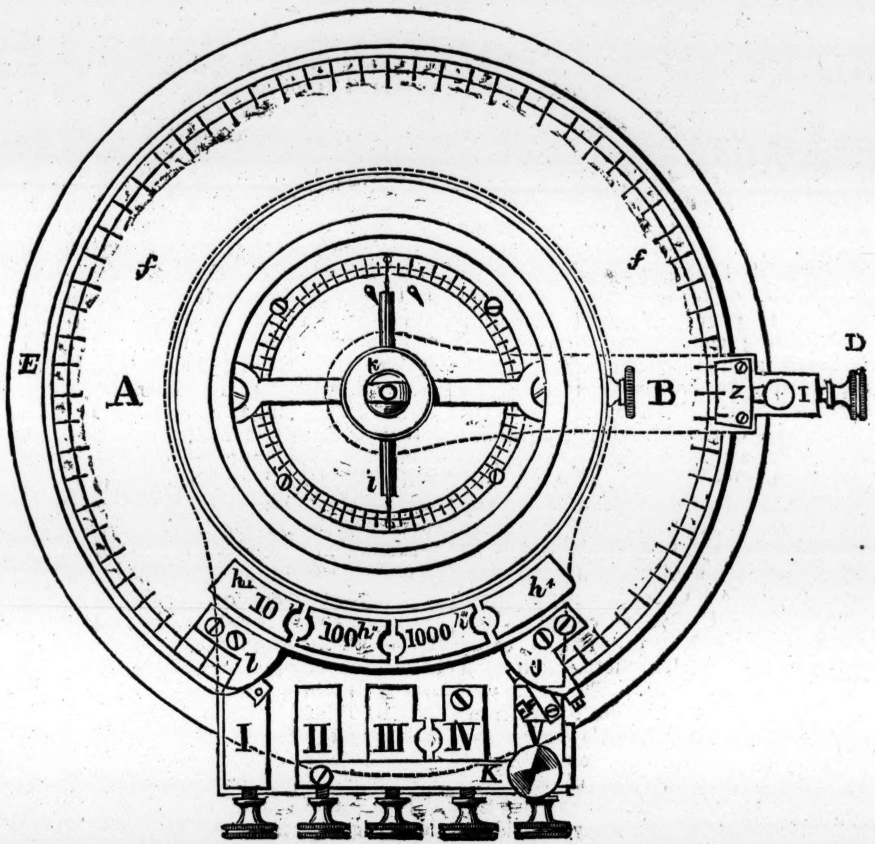
The instrument consists of a sensitive galvanometer, which can be turned in a horizontal plane, combined with a resistance bridge (the wire of which bridge instead of being straight is stretched round part of a circle). The galvanometer has an astatic needle, suspended by a cocoon fibre, and a flat bobbin frame, wound with fine wire. The needle swings above a cardboard dial divided in degrees: as, however, when using the instrument the deflection of the needle is never read off, but the needle instead always brought to zero, two ivory limiting pins are placed at about 20 degrees on each side of zero.

The galvanometer is fixed on a graduated slate disc, round which the platinum wire is stretched. Underneath the slate disc, three resistance coils—of the value of 10, 100, and 1000 Siemens's units—are wound on a hollow wooden block, which protrudes at one side, and on the projection carries the terminals for the reception of the leading wires from the battery and unknown resistance. The adoption of three different resistance coils enables the measuring of large as well as small resistances with sufficient accuracy.

The whole instrument is mounted on a wooden disc, which is supported by three levelling screws, so that it may be turned round its axle. On the same axle a lever is placed which bears at its end an upright arm, carying a contact roller. This roller is pressed against the platinum wire round the edge of the slate disc by means of a spring acting on the upright arm, and forms the junction between the A and B resistances of a Wheatstone's bridge, which resistances are formed by the platinum wire on either side of the contact-roller, one of the three resistance coils forming the third resistance of the bridge.

In the accompanying drawings Fig. 1 shows an elevation, and Fig. 2 a plan of the instrument.

Fig. 2.



G is the galvanometer; *k*, a milled head from which the needles are suspended, and by turning *k* they can be raised or lowered; *m* is the head of a screw which arrests or frees the needle when in motion. h_1, h_2, h_3, h_4, are the terminals of the respective ends of the three resistance coils—viz., 10, 100, and 1000 units—which are wound on the wooden block C: these terminals may be connected to each other by means of stoppers, and therefore one or more of the resistances may be brought into circuit as desired, and to the ends of these terminals the wires of the artificial resistances are connected. *f* is the graduated slate disc, round which the platinum wire is stretched in a slight groove at the edge of the disc, and is inserted in such manner that about half its diameter protrudes beyond the slate.

The ends of the platinum wire are soldered to two brass terminals, *l* and *l'*, which are placed at the angles formed by the sides of the gap in the slate disc, and which form the junctures, as in the ordinary resistance bridge, between A, *n*, and the galvanometer on one side, and B, X, and the galvanometer on the other side, of the parallelogram.

The terminal *l* is permanently connected by a thick copper wire or metal strip to terminal h_1, and the other terminal, *l'*, is connected in a similar manner to terminal III.

Slate is adopted for the material of which to make the disc *f*, because it is found by experience to be the material which is the least sensitive to variations in the weather or temperature.

The slate disc is graduated on its upper edge through an arc of 300 degrees, zero being in the centre, and the graduations figured up to 150 on each side at the terminals *l* and *l'* of the bridge wire.

In the centre of the circular plate E, of polished wood, supported upon three levelling screws, *b b b*, a metal boss is inserted, in which turns the vertical pin, *a*, which carries the instrument. This pin, being well fitted to the boss, supports the instrument firmly, but at the same time allows it to be turned freely round its vertical axis without losing its horizontal position when once obtained.

On the arm D D, which turns on the pin *a*, and somewhat behind the handle *g*, there is a small upright brass arm, *d*, turning between two screw points, *r*, and carrying in a gap at its upper end a small platinum jockey pulley, *e*, turning on a vertical axis. This pulley forms the movable contact-point along the bridge wire, against which it is kept firmly pressed by means of a spring acting on the arm *d*. The arm D D, which is insulated from the other parts of the apparatus, is permanently connected with the terminal I. On the top of *d* a pointer, Z, or a vernier, is fixed, which laps over the upper edge of the slate disc and points to the graduations.

To the pin *a* is attached a circular disc of polished wood, C, about 1 inch thick, and having a groove turned in its edge for the reception of the insulated wires composing the resistances. The disc C has a projection, *c*, which carries the five insulated terminals marked I., II., III., IV., V. Terminals III. and IV. can be connected by a plug, II. and V. by the contact-key, K. Terminal I. is in connection with the lever, D D.

The application of the universal galvanometer will be clear if the reader will consider the platinum wire between *l l'* as the bisected wire of the Wheatstone bridge.

THE HISTORY OF THE AUSTRALIAN OVERLAND-TELEGRAPH.

A LECTURE has been delivered in Adelaide by Mr. Charles Todd, C.M.G., Postmaster-General and Superintendent of Telegraphs, on "The Overland Telegraph."

Mr. TODD, after referring to the grand achievements of modern science, briefly sketched the early introduction of the electric telegraph; its rapid extension by land and sea, linking country to country, and continent to continent, and referred to the schemes propounded for connecting Australia with the telegraph systems of the world. The British-Indian, now the Great Eastern Telegraph Company, laid a continuous chain of cables from Falmouth to Lisbon, Gibraltar, Malta, Alexandra, down the Red Sea to Aden and Bombay. The British Indian Extension Company carried it on from Madras to Penang, and at this stage the British-Australian Telegraph Company was started to connect Singapore with the Australian land telegraphs, and Commander Noel Osborne visited these colonies in the early part of 1870 to complete the necessary negotiations. The first proposition came from Messrs. Brett and Carmichael, in a letter addressed to the colonial Governments in 1854. This offer was renewed in 1858, and when it first came before him, the proposal was to lay a cable from Ceylon to the west coast of Australia in two sections, connecting at the Cocos, or Keeling Islands. Another scheme was submitted in 1857 by Messrs. Carr and others; but the gentleman whose name was most intimately associated with Anglo-Australian telegraphs, although he was unfortunately unsuccessful, was Mr. Francis Gisborne. Mr. Gisborne's labours extended over 11 years, and he no doubt was instrumental in keeping the question before the public, and ultimately inducing English capitalists to take it up. He felt it due to Mr. Gisborne thus publicly to acknowledge his unremitting and valuable services, as it was his misfortune in advocating the Overland Line to have, to some extent, to oppose his views. It was not until after the explorations of Mr. A. C. Gregory in 1856, and those of Messrs. Babbage, Warburton, and Stuart in 1858, that he was led to consider the feasibility of carrying a line overland from Port Augusta to Cambridge Gulf. The whole thing, however, was premature then, and any attempt to connect Australia with the Indian telegraphs would have been a failure. Mr. Stuart's explorations in 1860, 1861, and 1862 fully confirmed the favourable view he took, and in his return from his last successful exploration, in which he reached the north coast near the mouth of the Adelaide, he reported that the line was perfectly practicable, and would pass through a vast extent of country available for settlement. On the arrival of Commander Osborne in April, 1870, he took the first opportunity of discussing with him his (Mr. Todd's) old project of a land line directly across the continent. Mr. Strangways, then Attorney-General, took the matter up, and on receiving an official report from him, a Bill authorising the necessary loan was drafted and laid before Parliament, and notwithstanding a Ministerial crisis, the Bill was passed by a large majority. The Bill was passed in June, 1870, and under the contract he had to open communication with Port Darwin by the 1st January, 1872. Only a few months before, the duties of Postmaster-General, in addition to the management of the Telegraph Department, had been transferred to him, and then he had to carry a line of telegraph, 1800 miles in length, through the very centre of Australia, 1350 miles of which was wholly unsettled by white men—through a county of which he knew positively nothing, except what Stuart had told them of the narrow strip he had traversed. The wire had to be procured from England, the insulators from Berlin, and when the order went home the cruel war had broken out, and serious delay occurred in getting the insulators through Belgium. These on arrival, as well as provisions for the workmen and a vast quantity of other materials and stores, had to be carted over many hundreds of miles of rough country without roads, some from Port Augusta, others after re-shipment from Port Darwin. He knew that much of the country north of Port Augusta was destitute of serviceable timber, and further acquaintance showed him that he had something like 400 miles of timberless country to bridge over. He then referred to the dispatch of Mr. J. Ross to explore the country as far north as the MacDonnell Ranges, arranging to meet him on his return at Mount Hamilton; also to the various sections which were let under contract to be constructed, the central and Northern Territory portions being carried out by Government parties in charge of competent surveyors, the Northern Territory section being divided between two parties—one working from Port Darwin as a basis, the other to be dispatched to the Roper, to commence somewhere near the Roper. Had that plan been adhered to it was his firm conviction—and he said it with all the experience he now had—the work would have been completed in time, and a vast amount of money would have been saved. He added, however, that everything was done after careful deliberation, that course being adopted which at the time appeared to be the best. The Government parties started from Adelaide in August, 1870. The first pole was planted at Port Darwin about the middle of September, and at Port Augusta on 1st October, 1870. In October, 1870, he went as far north as the Peake to meet Mr. Ross, and make final arrangements for the disposition of his forces. So far all went well, without a hitch. The country in the interior was even better than was anticipated, and there seemed every prospect of the work being completed within the specified time, when their hopes were blighted by the return of Mr. W. W. McMinn in the *Gulnare* from Port Darwin, who reported that the contractors' expedition in the Northern Territory had collapsed. That was early in July, 1871. In organising a fresh expedition to the Northern Territory, he strongly urged that the Roper should be the main basis of operations, especially as the poles had been erected for 225 miles from Port Darwin, and the adoption of the Roper would save nearly 250 miles of land carriage. It was, however, decided that less risk would be incurred by landing at Port Darwin, and a large expedition was rapidly fitted out, and placed under the charge of Mr. R. C. Patterson. Mr. Patterson fully concurred with him as to the value of the Roper, and, immediately on his arrival at Port Darwin, he (Mr. Patterson) arranged to send the Government schooner *Gulnare* round to the Roper with wire and stores, but unfortunately she was wrecked the day after starting, and Mr. Patterson transhipped her cargo into the *Bengal*, which vessel he chartered to proceed to the Roper on the same errand. It was drawing towards the end of the dry season, when all the feed was burnt up and the country was bare. Numbers of the horses and nearly one-third of the bullocks died, and the loads had to be lightened or abandoned on the road before the Katherine was reached, and further on it was necessary to sink wells before the teams could advance with safety; and ere this was accomplished down came the rains, and a monsoon of unusual severity set in almost before the work could be resumed, and stopped all further progress for months. In the midst of these misfortunes the cable fleet arrived at Port Darwin; the shore end was landed, the vessels started to pay out the cable to Banjoewangie, and in November communication was established with London, one of the first items of intelligence being—"South Australian land line not nearly completed." It was under these circumstances that Mr. Patterson telegraphed reporting his losses, and urged that large reinforcements should be sent up at once. The steamers *Omeo* and *Tararu* were then chartered, and he (Mr. Todd) proceeded in charge to take any steps he might feel necessary to secure the completion of the work. The *Young Australian* having been dispatched in advance, he sailed in the *Omeo* from Port Adelaide on the 4th January, 1872, in charge of a shipload of horses; but the day before he left communication was established with the MacDonnell Ranges, and he was gratified by hearing that the central sections were completed. But for their unexpected misfortunes in the Northern Territory he would have been able to fulfil South Australia's bargain. He likewise received the sad news that Mr. Kraagen—who was to have taken charge of the station at Alice Springs, in the MacDonnell Ranges—had died from want of water. He then alluded to his arrival at the mouth of the Roper, his meeting Mr. Patterson, and to his deciding to proceed in the *Omeo* up the Roper, after signing an agreement indemnifying Captain Calder from any loss which might accrue to the *Omeo* in crossing the bar. They only proceeded a few miles when the vessel got struck on a sand reach, where she remained for several days, and in the meantime, the *Young Australian* having arrived, he went in her up to the landing place with some of the cargo, passing the *Bengal*, where she had been anchored since the middle of December. Soundings being taken, they found there would be plenty of water, varying from three to nine fathoms in depth, but that care would be required to avoid several nasty rocks. The river was between 400 and 500 yards wide at the entrance, and for some 30 miles up, and at the landing, or depot, about 120 yards wide. At some points, particularly at Moleshill, the scenery was most beautiful, and some large swamps were profusely covered with blue lilies, while all around was fine park-like country. The river during the wet season is subject to immense freshets, when the waters rise at the landing over 30 feet, and the country is flooded for miles. Continuous and heavy rains lasted all through February and March, during which nothing could be done, but directly the fine weather set in, and the roads became passable, they loaded up teams, and Mr. Patterson went on to the working parties, while he went to Port Darwin to complete all the arrangements, and inspect the building there, and have the line between Port Darwin and the Katherine thoroughly overhauled, their enemies the white ants having brought it to grief during the wet season, and stopped the communication. He arrived at Port Darwin on 8th May, and was very pleased with the place, and greatly admired its fine natural harbour, which was destined, he believed, to become a port of large commerce. The only decent buildings were the Residency and the Telegraph Offices, which stood on elevated ground commanding a fine view of the harbour. He went up to Southport, where he landed a large number of iron poles, and carefully inspected several miles of line, and having completed his task started on his return to the Roper on May 22nd, arriving on the 31st. He wished if possible to return overland from Port Darwin, but no horses could be spared. After staying at the Roper he started with Mr. Patterson for the Daly Waters on his overland journey to Adelaide, on June 13th, making a final start, arriving at Daly Waters on the 22nd, where he met Mr. Boucaut. He then referred to the establishment of an estafette, or horse express service, between this point and Tennants Creek, and to his having spoken Port Darwin, and sent a message to the Agent-General in London, informing him of the state of the work. On the following day a number of messages came through from London, but before he could get a reply the cable between Port Darwin and Java broke, and communication was not restored for several months. Mile after mile the communication with Adelaide was maintained on the land line by a field operator, and the gap was then gradually closed, and finally the two ends of the wire were joined on August 22nd, and communication was established right through between Adelaide and Port Darwin—a distance of nearly 2000 miles. Thus the great work, notwithstanding all disasters and mishaps, was successfully accomplished within two years. On his arrival at Beltana on October 18th, he heard that the cable had that day been picked up by the repairing ship which had signalled the Port Darwin Office, and on the following Monday communication was restored, and Australia for the first time reaped the fruits of South Australia's enterprise. He remarked that he need not enlarge on the advantages to the other colonies of telegraphic communication. He was assured by merchants most competent to form an opinion, that the telegraph had realised for the colony at least £150,000 in the advanced price it had enabled us to obtain for our wheat. The telegraph might check unhealthy speculation, but it made commerce safer, tended to equalise prices, put farmer, merchant, and consumer on a footing of fair equality, and by the more speedy liberation of capital it cheapened all commodities and the necessaries of daily life.

Telegraph wires were laid on to the room, and at the termination of the lecture Mr. Todd sent messages to Alice Springs Station, on the Overland Line, and to Port Darwin, and also to Banjoewangie, Singapore, and Batavia, and answers were returned in a very few minutes.

Students' Column.

Resistances and their Measurements.—By H. R. Kempe.

III. Before proceeding to describe the more intricate systems of measurement, we will describe some of the forms of instruments which would be used in making measurements such as we have described.

First, the Resistance Coils—

The essential points of a good set of resistance coils are, that they should not vary their resistance appreciably by variation of temperature, and that they should be accurately adjusted to the standard units, and this adjustment ought to be such that not only should each individual coil test according to its marked value, but the total value of all the coils together should be equal to the numerical sum of their marked values. It will be frequently found in imperfectly adjusted coils that although each individual coil may test, as far as can be seen, correct, yet when tested all together, their total value will be 1 or 2 units more or less than their numerical value; because, although an error of a fraction of a unit may not be perceptible in testing each coil individually, yet the accumulated error may be comparatively large.

The wire of the coils is, as a rule, of German silver, the specific resistance of which metal is but little affected by variations of temperature. The wire is insulated usually by a double covering of silk, and is wound double on ebonite bobbins, the object of the double winding being to eliminate the extra current which would be induced in the coils if the wire was wound on single. By double winding, the current flows in two opposite directions on the bobbin, the portion in one direction eliminating the inductive effect of the portion in the other direction. When wound, the bobbins are saturated in hot paraffin wax, which thoroughly preserves their insulation, preventing the silk covering from becoming damp, which might have the effect of short circuiting the coils and thereby reducing their resistance.

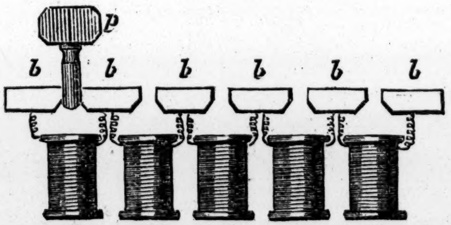
The small resistances are made of thick wire, the higher ones of thin wire to economise space.

When bulk and weight is of no consequence, it is better to have all the coils made of thick wire, more especially if high battery power is used in testing, as there is less liability of the coils becoming heated by the passage of the current through them.

A set of resistance coils generally consists of a number of coils of such values that any resistance from 1 to 10,000 can be obtained. One arrangement in general use has coils of the following values:—1, 2, 2, 5, 10, 10, 20, 50, 100, 100, 200, 500, 1000, 1000, 2000, 5000 ohms.

These numbers enable any resistance from 1 to 10,000 to be obtained, using a minimum number of coils without fractional values. With these numbers, however, it is a matter of some little difficulty to see at once what coils it is necessary to put into circuit in order to obtain a particular resistance; and as it is often necessary to be quick in changing the resistances, the following numbers are frequently used:—1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400, 1000, 2000, 3000, 4000.

Fig. 3.

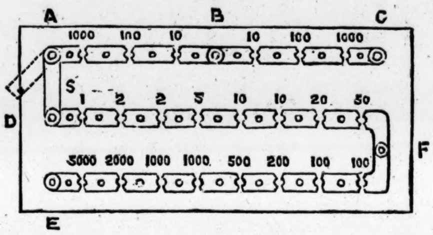


With these numbers, any particular resistance that is required to be inserted can be seen almost at a glance.

The way in which the different coils are put in circuit is shown in Fig. 3. The ends of the several resistances, *c*, *c*, *c*, ... are inserted between the brass blocks, *b*, *b*, *b*, ... Any of the coils can then be cut out of the circuit between the first and last blocks by inserting plugs, *p*, between the blocks as shown, which short circuits the coils between them; thus, if all the plugs were inserted, there would be no resistance in circuit, and when all the plugs were out, all the coils would be in circuit.

There are various ways of arranging the coils in sets; one of the most common is that shown in Fig. 4. This form is much used in submarine cable testing. The brass blocks, here shown in plan, are screwed down to a plate of ebonite which forms the top of the box in which the coils are enclosed. The ebonite bobbins are fixed to the lower surface of the ebonite top, the ends of the wires being fixed to the screws which secure the brass blocks. The holes shown in the middle of the brass blocks are convenient for holding the plugs that are not in use. It will be seen that six binding-screws, A, B, C, D, E, F, are provided; when we only require to put a resistance in circuit, the two screws D and E would be used. The use of the other screws and of the movable brass strap, *s*, will be explained hereafter.

Fig. 4.



In using a set of resistance coils, one or two precautions are necessary. First of all, it is necessary to see that the brass shanks of the plugs are clean and bright, as otherwise the insertion of a dirty plug will not entirely cut out of circuit the coil it is intended to; it is a good plan, before commencing to test, to give the plugs a scrape with a piece of glass or emery paper, taking care to rub off any grains of grit which may remain sticking to it after this has been done.

When a plug is inserted, it should not be simply pushed into the hole, but a twisting motion should be given it in doing so, so that good contact may be ensured; too much force should not be used, as the ebonite tops may be thereby twisted off in extracting the plugs. Care also should be taken that the neighbouring plugs are not loosened by the fingers catching them during the operation of shifting a plug.

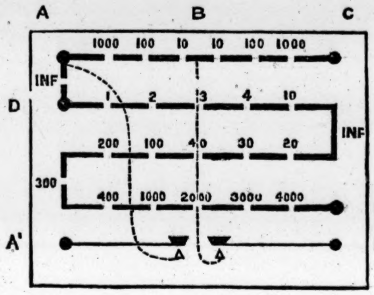
Before commencing work, it is as well to give all the plugs a twist in the holes, so as to see that none of them are loose. On no account must the plugs be greased to prevent their sticking, and their brass shanks should be touched as little as possible with the fingers.

For taking the insulation resistance of a line in the manner described in the last article, such an elaborate set of coils is not of course required. A single coil of a resistance of 1000 ohms in a box with two binding-screws, to which the ends of the coil are attached, is all that is required.

One of the most useful set of coils for general purposes is that shown in outline in Fig. 5. The general arrangement of resistances, it will be seen, is the same as in Fig. 4. Two keys, however, are provided (shown in the figure in elevation for distinctness), the contact point of the left hand key being connected, as shown by the dotted line, with the middle brass block of the upper set of resistances, the binding-screw B′ at the end of the key corresponding, in fact, when the key is pressed down, with the binding-screw B shown in Fig. 4. In like manner, the binding-screw A′ corresponds with the binding-screw A. In the place of the movable piece of brass between A and D, a plug marked INF. (infinity) is provided, which answers the same purpose; an infinity plug is also placed at the second bend of the coils at the left hand of the figure.

When we require simply to insert a resistance in a circuit, we should use the binding-screws A′ and E, the left hand key being pressed down when the deflection of the galvanometer needle is to be noted. The current can thus be conveniently cut off or put on when required by releasing or depressing the key. Care should be taken that the two *infinity* plugs are firmly in their places, to ensure their making good contact. The key contacts should be occasionally touched with emery paper or a fine file, to ensure their contact being good.

Fig. 5.



(To be continued).

Correspondence.

AUTOMATIC TELEGRAPHY.

To the Editor of the Telegraphic Journal.

SIR,—I will, with your permission, make a few remarks in relation to static induction in land lines, more especially, as much misconception has arisen among various parties as to what I claim or regard as the salient or essential features of my system of rapid automatic telegraphy.

In the first place, I consider that the chief function of the condenser consists not so much in the clearing of the wire of an air line of telegraph of static charge, as in the absorption of extra current induced in the helices of magnets inserted in the main line, brought about by making and breaking battery contact, and giving rise to a second and a third current.

The third induced current which is created in the helices upon breaking battery contact, had, previously to the introduction of the condenser, offered the most serious obstacles to the rapid transmission of signals.

This can be verified by a very simple experiment on the laboratory table. Connect a condenser, having an inductive surface of about eighty square feet, and possessing an electro-static capacity of about one-third of a micro-farad on each side of an ordinary relay, with a resistance of about two hundred ohms.

Then, on making contact in the usual way with a local battery, it will be observed that the armature of the relay will not adhere to the cores of the magnet, and it will also be found that it matters not how rapid the contacts are made and broken with the battery.

Now separate one of the connecting wires of the condenser. The armature will no longer leave the cores unless greater tension be given to the retractile spring of the armature.

Whoever performs the *experimentum crucis* will also see at a glance the advantage that would accrue from the application of the condenser to the Morse instrument now in daily use, by enabling the operators to work on a more delicate adjustment than ever before known.

Now, on an air line proper, without any helices in circuit, the tendency of a static charge is, as shown by Faraday, to divide and dispense at both ends simultaneously, provided a passage be offered therefore. It must be a highly insulated line, indeed, that will retain a sufficient static charge so great as to require a condenser of an electro-static capacity equal in area to the whole surface exposed by the line wire itself.

Those of your readers who have not investigated this wonderful phenomena will find a lucid explanation of the use of the condenser (as employed by me in combination with my rapid system of automatic telegraphy, and as also used by Mr. Stearns in combination with his duplex telegraph) in Mr. Culley's work. Another important feature, as used by me in combination with my system, is the application of any adjustable rheostat, as in my application (Patent of 1869)—or a series of adjusted rheostats, mounted or not in a frame, or on or in a base, as described in my patent of September 10th, 1872, and applied either in a shunt circuit or in a branch circuit, as used in combination with the duplex systems of Gintl and others, and described in their Austrian Patents in 1853. A description, also, is printed in the *Polytechniches Blatts, Vienna*, 1854-5, as also other German and French works of the above dates.

Another very important feature in my system is the application by me of the lifting blade, in order to prevent overwinding, sticking, and constant breaking of the paper strip, which used to occur six times out of ten during the reception of a telegram, requiring the repetition of a telegram at the transmitting end of the line as often as a break occurred at the receiving end of the line, and thus another serious difficulty has been completely overcome.

Another feature consists in the attachment by myself of the clearing brush or detainer, the nipping roller, stylus, or transmitting discs to one arm or lever, thereby facilitating the handling of the instruments by the operators.

My patent formula for the canary-coloured receiving paper, deliquescent or moisture-absorbing preparation, and also the utilisation of waste stock, forms no small item of saving in the running of my system.

In fact, the various modifications of principles involved in my automatic systems of the first and second order, including perforators, &c., required over forty applications for protection on the continent of America, and also upwards of thirty applications on the continents of Europe and Asia, for which I hold a corresponding number of patents.

In conclusion, it is proper to state that my Automatic Telegraph system has been in successful operation in the United States for over two years, under the Automatic Telegraph Company, of which Hon. George Harrington, of Washington, D.C., is President.

GEORGE LITTLE.

Rutherfurd Park and Passaic City,
New Jersey, December 1, 1873.

[An illustrated description of Mr. Little's automatic system will appear in our next issue.—*Ed. T. J.*]

METHOD OF DETERMINING THE ACTUAL RESISTANCE OF OLD TELEGRAPH LINE WIRES.

To the Editor of the Telegraphic Journal.

SIR,—In your journal of the 15th inst., I am accused by J. W. Hagers, inspector of the Government telegraphs in the Netherlands, of reproducing a formula of his, and publishing it as my own.

The article "Method of Determining the Actual Resistance of Old Telegraph Line Wires," published in your journal of 15th May *is not written by me*, nor is my name mentioned in connection with the article.

I am referred in Mr. Hager's note to an article by Mr. Ayrton, in the journal of the 1st inst. Mr. Ayrton's note had escaped my notice until now.

I desire to say to Mr. Ayrton that the object of my article "On Economical Line Construction," was to show the advantages of perfect insulation, or insulation that is not effected by dampness. In this case a heavy and expensive conducting wire is not essential.

My business is the manufacture of insulators. I guarantee their performance. One of these guarantees is that they shall not be affected by rain or damp weather. I undertake to insulate a wire weighing, say, two hundred pounds per mile, and thereby make the capacity of that wire equal to another wire, weighing four hundred pounds per mile. This latter wire being insulated with common insulators—such, for instance, as are used in the British East Indies, the Netherlands, or England. I do it and maintain this degree of insulation for a moderate charge—less than is usually expended for such purposes, asking no pay unless these conditions are fulfilled.

To Mr. Ayrton I beg to say I have not had the good fortune to read "Instructions for Testing Overland Lines," compiled by Mr. Schwendler, nor "The Instructions for Testing Telegraph Lines, and the Technical Arrangements in Offices." I have no doubt that I would be interested and profited by doing so.

I and others in this country have applied Mr. Schwendler's formula to correct the apparent or observed resistance of old telegraph lines. I refer to the formula as published by Clark and Sabine. We have been unsuccessful, however, in getting at anything like an approximation to its actual resistance for these reasons: (1.) The resistance of the insulators is seldom if ever uniform for the entire length of line, but constantly changing. (2.) Conductivity of old wires is more reduced by bad joints than by loss of actual weight of metal. The resistance of defective joints is reduced by dampness, in some instances sufficient to make a difference in the apparent resistance of the wire of more than one hundred per cent.

In measuring the resistance of old wires to determine the loss in conductivity from use and exposure, it is perfectly useless to attempt it, except in clear or cold weather. In one instance the resistance of an old wire reinsulated was reduced over three hundred per cent by rain, as compared to a measurement in clear weather. In dry weather in this country the resistance of the insulators is too great to enter into or affect the result. It is beyond the scope or range of the Siemens's universal galvanometer. *It is so in rain*, where my insulation is used. Rain or dampness does not affect this insulation. We can then observe and realise the effect of dampness upon the bad joints.

My knowledge of the telegraphs in the British East Indies is derived chiefly from the London journals. If there is improvement I am glad to hear of it. I have in my business of reinsulating telegraph lines distributed over thirty of Siemens's universal galvanometers, nearly all of them to railway companies. In the manufacture of these insulators, I employ the most sensitive galvanometers, using those made especially for the purpose by Ruhmkorf, Dr. Werner Siemens, and Mr. Becker. If we do not keep pace "in the application of scientific laws to practical questions," we are determined not to be so far behind the rest of the world as to *lose sight* of those that win in the race.—I am, &c.,

DAVID BROOKS.

To the Editor of the Telegraphic Journal.

SIR,—Referring to the article on a "Method of Determining the Actual Resistance of Old Telegraph Line Wires," I find it in *The Telegrapher* of April 12th, 1873 (not April 5th) under the signature of "J. H." There is evidently some mistake in imputing it to Mr. Brooks, as his name does not appear in connection with it in any way. The article in question, I find by comparison, to be a translation of Mr. Hager's article in the *Annales*, as stated in his letter in your journal of November 15th.—I am, &c.,

F. L. POPE.

Elizabeth, New Jersey, U.S.A., Dec. 1, 1873.

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvii., No. 21.

On the Discharge of Electrified Conductors.—By M. Moutier.—Reserved for full translation.

On the Variable State of Voltaic Currents.—By M. P. Blaserna.—A reply to M. Cazin.

No. 22.

Note upon Magnetism.—By M. A. Trève.—Last year I had the honour to present to the Academy several experiments revealing, under diverse forms, the *magnetic* movement to which magnetism gives place. I have obtained, for example, by means of an electro-magnet, of which the branches are 6 metres long, induction currents, the direction of which varies with that of the inducing current. Given a very long bar of iron, of which one extremity is furnished with a powerful inducing bobbin, and upon which can be made to slide an induced bobbin (of fine wire), I have studied some of the conditions under which the magnetic movement is propagated, and have noted, for example, the very decrease of intensity of induced currents with the same inducing consequent upon lengthening the induced bobbin with relation to the inducing bobbin, and the influence of the section of the bar of iron upon the intensity of the same currents. But the latter struck me more particularly, and what appeared to be the most useful consequence of this series of researches is the notable retardation of the induced currents arriving, over the inducing currents departing, that is to say, that the magnetic movement, upon which I believe I was the first to speak to the Academy, is relatively slow with relation to the electric movement.

On the Difference in Physiological Action of Induced Currents, according to the Nature of the Metallic Wire, forming the Induced Bobbin.—By M. Onimus.—I have endeavoured to ascertain the effect of induced bobbins of various metals, especially from a physiological point of view. I have made, exactly under the same conditions, induction bobbins with wires of copper, with wires of lead, and with wires of German-silver. The diameter of the wire was the same; the length was 210 metres for each of the wires. All the bobbins were constructed in the same manner, and were influenced identically by the inducing current. Upon the nerves and muscles of a healthy man the effects of the shocks were different, according to the nature of the metal, and it may be stated generally that when the wire of the induction bobbin is formed of a metal which is a bad conductor of electricity, the contraction is stronger, and the impression upon the cutaneous nerves less vivid than with wires of good conductors, copper for example. These effects are as much more marked as the exterior resistance is the greater. Also, in passing the current across alcoholised water, and in diminishing it to a minimum until the muscular contractions no longer take place with the current from copper wires, we still obtain, under the same conditions, contractions with the current from wires of German-silver. Lead being a worse conductor than copper, but a better conductor than German-silver, gives intermediate effects. The high price of platinum has prevented my making experiments with that metal. Upon superficial muscles the difference between currents from a bobbin of copper wire and those from a bobbin of German-silver is much less perceptible. The impression from currents from lead wire is greater. Upon the sensitive nerves, situated in the depths of the tissues, the excitation is much more vivid than with currents from copper wires, but less acute and pricking. We may conclude from these facts that the induced current from both conducting wires has a higher tension than that from wires which are better conductors of electricity. I have undertaken some researches, in connection with Dr. Legros, upon the muscular contractions of different animals treated with the several coils. The effects obtained indicate in a very clear manner the more energetical action of the current from the bobbin of German-silver wire. In employing a minimum current, and in experimenting under identical conditions, the curve which is formed by each muscular contraction is much more elevated with the German-silver bobbin than with the copper bobbin. The contractions with the German-silver bobbin are also more regular, and show all the phases of the double shock due to the opening and the closing of the current. The lever of a metronome was employed as an interrupter. The trace obtained with the copper bobbin showed more irregular contractions. These differences are much more marked as we withdraw from the muscle and across the epidermis. If we insert the rheophores in the muscle and register the trace, the difference still exists, but it is much less distinct. These experiments show that the tension is higher with induced currents from wires of lead or German-silver. If, then, currents from leaden wires have a higher tension than those from copper wires, they have, *per contra*, an inferior quantity, due to the low conductivity of these metals. Also, by experiment with these same bobbins, while the current furnished by the copper wires gave, upon a galvanometer, a deflection of 20° to 25°, the current furnished by lead wires produced on the same galvanometer only a deflection of 1½°, and the German-silver wires a deflection of ½° only. The construction of bobbins with lead wires offers some difficulty, especially when the wire is fine, but that of bobbins of German-silver is easy, and such bobbins can with advantage be employed in electro-medical apparatus.

No. 23.

On the Use of Galvano-Cautery in Surgical Operations.—By MM. Legros and Onimus.—A purely surgical paper.

Scientific American, Vol. xxix., No. 21.

Electro-Music Reporter—A novel application of electricity to musical instruments, for the purpose of recording the inspirations of genius in musical compositions, is now in process of construction for Mr. C. T. Shelton, of New Haven, Conn. It is a telegraphic attachment to an organ. Beneath each note of the three manuals and of the pedals, and connected with each stop of the organ, is a small brass spring, which is pressed down whenever the piece to which it is attached is brought into action. From each spring wires run to a galvanic battery of twelve cells, and to the recording apparatus, which may be situated at any convenient distance from the organ. When the spring is pressed down, connection between the battery and the recording apparatus is formed, and the electric current passes through. The recording apparatus is very simple, and similar to that used in Morse's telegraph. Attached to the clockwork, by which a uniform motion is produced, are two cylinders, some 18 inches in length, between which is carried a strip of paper divided into about 250 longitudinal divisions—one for each note and stop in the organ. Corresponding to each of these divisions is a magnet whose armature carries a lever armed with a style, which indents the paper as long as the electric current is passing through. Now, when any note or stop is brought into action the spring connected with it is pressed down, the circuit is completed, the corresponding armature is attracted to its magnet, and the division of the paper belonging to the note struck is indented with a line proportionate in length to the time during which the note is held down. A staccato touch will be represented by a simple dot, while a longer tone will be recorded by a more prolonged indentation. The clockwork is so geared that the paper is carried forward on the rollers at the rate of about one-half an inch per second, thus recording each note in the most rapid playing at the rate of about ten notes per second by a line one-twentieth of an inch in length, and longer notes by lines proportionally extended.

No. 23.

A Novel and Simple Electric Light.—Dr. Geissler, of Bonn, Germany, whose name is inseparably associated with some of the most beautiful experiments that can be performed by the agency of electricity, makes an electrical vacuum tube that may be lighted without either induction coil or frictional machine. It consists of a tube an inch or so in diameter, filled with air as dry as can be obtained, and hermetically sealed after the introduction of a smaller exhausted tube. If this outward tube be rubbed with a piece of flannel, or any of the furs generally used in exciting the electrophorus, the inner tube will be illumined with flashes of mellow light. The light is faint at first, but gradually becomes brighter and softer. It is momentary in duration; but if the tube be rapidly frictioned, an optical delusion will render it continuous. If the operator have at his disposal a piece of vulcanite, previously excited, he may, after educing signs of electrical excitement within the tube, entirely dispense with the use of his flannel or fur. This will be found to minister very much to his personal ease and comfort. He may continue the experiments, and with enhanced effect, by moving the sheet of vulcanite rapidly up and down at a slight distance from the tube. This beautiful phenomenon is an effect of induction.

Der Naturforscher. October, 1873.

The Reaction-time of the Sensorium.—M. Exner.—This describes a series of experiments in a similar direction to that of Donders's, viz., to ascertain the time elapsing between the stimulation of a part of the body, and a signal made by the person when he has become conscious of it. The signal was made by pressing a key; and the time of stimulation and signalling were both indicated by marks on a rotating blackened cylinder; the interval indicating the "reaction-time." In seven persons of different age, the reaction-time (minimum 0·1295, maximum 0·3576) appeared independent of age; it seemed shorter in those who had the habit of concentrating their attention. Again, where one mode of measurement of the reaction-time, with one individual, gives a smaller number than another, the same mode, with another individual, also gives a smaller number than the other. This is clearly shown by tabulated results of experiments, with different stimuli on five individuals. Further, it is shown that the shortest reaction-time occurs with the mode of measurement, in which the eye is stimulated directly with an induction shock; then follow, successively, electric shock to finger of left-hand; hearing of sudden sound; electric shock on forehead; shock to finger of right-hand; sight of a passing electric spark; and, lastly, a shock to toes of left foot. Weak stimuli give on the whole larger numbers (for the reaction-time) than strong. The reaction-time diminishes with practice; but fatigue has the opposite influence. After taking two bottles of Rhine wine, the reaction-time rose from 0·1904 to 0·2969 sec. Tea, and a small dose of morphium, had no effect. M. Exner analyses the reaction-time into seven epochs. (1) The time taken by the apparatus of sense to transform the incident *vis viva* into nerve stimulus. (2). The time taken by the stimulus to pass to the central nerve system. (3). The time of passage in spinal cord. (4) The time of the central transformation into motor stimulus. (5). The time of returning conduction by cord. (6). The time of conduction by motor nerve. (7). The time of liberation (*Auslösung*) of muscular movement. M. Exner studies specially 1, 3, 4 and 5. As to the first, he experimented on the eye, comparing the reaction-time where the retina was stimulated with light with that where there was direct stimulation of the optic nerve with an electric shock. The difference might be taken as denoting the time required by the retina to translate the light impression into a nerve stimulus. The former reaction-time was found 0·1506 sec.; the latter 0·1139. But with stronger light stimulus, the former fell to 0·1229; and in the other case, a minium of 0·1007 was got. The author can only assert the probability of a latent stimulation of the sense; *i.e.*, that after the image of the electric spark has been formed on the retina, a moment occurs, in which the nerve substance prepares the forces incident on it; but has not so far prepared them that they can give an excitation of the nerve. The velocity of conduction in the spinal cord was, for sensation, 8 metres per second; for motion, 11 to 12 metres. The "reduced reaction time," or that required for central translation of the sensation stimulus into a motor, is obtained by subtraction of the time of conduction extraneous to the brain; it varies (like the reaction-time) with attention, strength of stimulus, and practice.

As to practice, which, in an old man of seventy-six, brought down the reaction-time from 0·9426 sec. to 0·1340 sec. in the course of a few months; it was observed that the decrease of the reaction-time was not continuous, perceptible from experiment to experiment, but that it occurred in "springs," and that these took place in the pauses between the series of experiments. Thus the old man learned to react more quickly in the course of days in which he made no experiments.

Short Galvanic Currents and Electrical Discharges.—M. Edlund.—Suppose that the discharge of an electric battery passes, successively, through a galvanometer, and a Reiss electric thermometer, and that the circuit is exclusively metallic, except were the spark passes. Call the heating of air in the thermometer A, and the galvanometer deflection B. Further, suppose a galvanic current, so short in duration that its action may be considered as a shock (*Stoss*) to pass, similarly, through both instruments; and call the corresponding data here a and b. Then, so long as the resistance of the circuit is not too great, the surface of the armatures of the Leyden jars not very large in comparison to the quantity of electricity accumulated, or so long as the galvanic current is not of very great intensity, $\frac{A}{B} > \frac{a}{b}$; that is, the relation of heat-action of the discharge to the power of the latter to put the magnetic needle in motion will always be greater than the same relation for the galvanic current. Three examples are given, illustrating this long-known fact, showing for the galvanic current, strong magnetic, and little heat-action; for the electric discharge, the opposite. As to galvanometer deflections, through the discharge, they are proportional to the quantity of electricity which goes through the coils of the instrument. If q denote this quantity, and f a constant, then $B = fq$. As to the galvanic current's action on the galvanometer, it is proportional to it; where $i =$ intensity of the current, and $t =$ the time of action. The intensity $= mh$; m being the quantity of electricity moved through unit length of the conductor, and h its velocity; and the quantity passing through the coils of the galvanometer is thus $m\,h\,t$. If we call this quantity q', then $b = fq'$. There is no reason to suppose the constant f different in the two cases. It thus follows, that if the galvanometer gives, with the discharge current of the battery, a deflection equal to that of a certain galvanic current of short duration, the quantities of electricity which pass through are, in the two cases, equal. The heat-action of the electric discharge is, according to Riess, proportional to the quantity of the discharged electricity multiplied by its density, and in inverse proportion to a quantity which grows with the resistance of the current. We may thus diminish the proportion of A to B by increasing, either the resistance of the circuit, or the coating of the Leyden jar. The quantity of heat produced by a galvanic current passing through a wire with constant intensity is proportional to the square of this intensity; and equal quantities of heat are developed in equal times. If the current acts only a very short time, the development of heat may be supposed approximately equal to the square of the intensity multiplied by the duration of its action. We may, then, increase the proportion between a and b by using a greater intensity of current. During the discharge, the active electrical forces do a mechanical work through which the electric mass is put in quick motion. When, after the discharge, the electricity comes to rest, this entire mechanical work is transformed into heat, with exception of the part which was necessary for breaking through the surface of the pole, and producing a spark. This is supposing the discharge produces no physical modifications in the circuit, or ought else than heat. In the circuit through which a galvanic current passes, we similarly find transformed into heat the entire work done by the electromotive forces; at least where the current produces no chemical decomposition, and does no external mechanical work through electro-magnets, in which case the heat production is less. Suppose now, that the discharge of the battery, as also the intensity and duration of the current are so chosen, that the discharge and the galvanic current give equal deflections of the galvanometer, *i.e.*, $B = b$. We then know that, in the two cases, equal quantities of electricity pass through the galvanometer coils. In the air thermometer, on the other hand, the discharge produces a much greater heat-effect than the heating a by the galvanic current (it being supposed that the resistance in the circuit, and the coated surface of the battery are not of extraordinary size, and that the intensity of the galvanic current is not very considerable). Although, then, equal quantities of electricity have, in the two cases, coursed through the platinum wire of the instrument, the passage of the discharge has transformed a greater part of the work into heat than the passage of the galvanic current. This can only be explained one way, viz., that the velocity of the electricity is greater in the discharge than in the galvanic current. Call the former H, the latter h, then $H > h$. The same applies to the case where B is not equal to b, supposing that $\frac{A}{B} > \frac{a}{b}$. If the quantity of electricity q, which, during the discharge, passes through the galvanometer, be equal to n times the quantity q', which passes when the galvanic circuit is closed, the deflection B will be equal to nb. At the same time $A > na$. While, in the first case, the air thermometer is traversed by a quantity of electricity equal to n times that which passed in the second case, the quantity of the work done in the first case is more than n times that in the second. This is only possible when $H > h$. If, then, within the limits above given, $\frac{A}{B}$ is always greater than $\frac{a}{b}$, it follows that within the same limits $H > h$; or, *the velocity of electricity in the discharge current is greater than in the galvanic current.* Owing to the great difficulties attaching to experimental determination of the velocity of electricity, the researches which we have on this subject are neither so exact nor so perfect as is necessary. Wheatstone estimated the velocity of battery discharge in a copper wire at about 690 metres in a millionth of a second. The velocity of the galvanic current in the same kind of wire and for the same time is given by Fizeau and Gounelle, 180 metres; and 100 metres in an iron wire. In a copper telegraph wire, between Greenwich and Edinburgh, the velocity for the same time was reckoned to be 12 metres. Walker found the velocity in an iron wire 30 metres; while Gould's estimate was 26 metres. If we take Fizeau and Gounelle's proportion 1·8 between the velocity in a copper wire and an iron wire, we obtain from the two last values for copper wire the values 54 and 47. Doubtless the velocity of galvanic electricity varies with circumstances, and to this must be attributed the differences in the results obtained. Taking the mean of the determinations, we have, for the velocity of galvanic electricity, 73 metres in the millionth of a second, which is only the tenth part of the velocity found by Wheatstone in the case of the battery discharge. These researches, then, seem to lend support to the assertion that the velocity of electricity in the discharge of the battery is much greater than that of the galvanic current.

On the Action of the Electric Spark on Atmospheric Air.—When the spark of an electro-magnet induction apparatus is passed between two platinum electrodes, in a glass vessel containing perfectly dry air, the vessel soon becomes filled with yellow vapour of *nitrous acid.* If, however, the same experiment is made with moist air, the inner walls of the vessel having been previously well moistened with distilled water, and some water being left in the bottom, this yellow vapour does not appear; but the enclosed air gives, ere long, the characteristic smell of ozone, and the water furnishes a quantity of hyponitric acid. Hence, in testing of free atmospheric air, with reference to its ozone contents, by means of the so called ozonometric paper (formed with starch and iodide of potassium), this is apt to be a very deceptive reagent, inasmuch as the blueing effect may be due to nitrous acid as well as ozone, according to the hygrometric state of the air.

ELECTRIC RAILWAY SIGNALS.—Several railway telegraph superintendents, writing with reference to electric railway signals exhibited at Vienna, ask for particulars of the origin of the extraordinary invention, known as the "Light Indicator." It would occupy too much space to give the entire history of the bringing out of this apparatus, but suffice it to say that the patentee of the instrument (who, we understand, was not the inventor) patented "the expansion of metals in any shape or form, or any other material;" subsequently, however, the original inventor brought out an appliance, worked by the expansion of atmospheric air, which we believe is now generally employed, though others have since been introduced, one especially being a metallic arc, which is reported to have some advantages. What we have said, of course refers solely to the appliance that is fixed inside the lamp; the indicator instrument in the pointsman's box has always been the same.—*Railway Service Gazette.*

City and Commercial Notes.

AN extraordinary general meeting of the Western and Brazilian Telegraph Company (Limited) was held on the 17th December at the Cannon Street Hotel, Mr. Heugh in the chair. The chairman said the object of the meeting was to approve an agreement, made on the 8th inst., between this company and the liquidators of the Great Western Telegraph Company, relative to the cancellation of the shares issued to the shareholders of the latter company, and the allotment and issue of other shares of this company in exchange for the said shares, credited with the like sum as paid up thereon. His colleagues at the Board, however, had requested him to state the present position of the company. The line from Para to Pernambuco was laid and at work. The ship *Hooper* was now on the coast, laying the southern portion of the line from Rio. The further lines between Rio and the River Plate had been purchased by the company and the deposit money paid. A repairing ship had been bought by the directors to sail along the coast and look after the cables. As soon as the ship *Hooper* returned home she would take out the West India cable, and he hoped the whole of their system would be completed and at work in a short time. Another satisfactory matter was that all moneys due to the contractors had been paid, and the company was absolutely out of debt. He concluded by moving a resolution approving the agreement relating to the shares and empowering the directors to carry its provisions into effect. Mr. Buckley, M.P., seconded the resolution. Sir J. H. Maxwell expressed the gratification he felt at hearing the favourable statement of the chairman. The resolution was then unanimously adopted.

At the meeting of the West India and Panama Telegraph Company on the 15th inst., a long discussion took place as to the reception of the report of the Shareholders' Committee. The meeting was in favour of adopting their recommendations, but, upon an intimation from the chairman that it was the intention of the board to use proxies of absent shareholders in their favour, although given prior to the appointment of the committee, a motion was carried adjourning the meeting for one month, in order that the absent shareholders may have an opportunity of forming an opinion upon the questions at issue.

Messrs. Hambro and Son announce the payment this day of interest at the rate of 5 per cent per annum on the shares of the Great Northern Telegraph Company.

Hooper's Telegraph Works (Limited) have received the following telegram from Mr. France, their engineer in chief, announcing the successful laying of the Pernambuco-Bahia section of the Western and Brazilian Company's cables:—"Cable successfully laid on the 11th of December. Insulation superb. Start from Rio about the 25th."

The special meeting of the Western and Brazilian Telegraph Company (Limited), convened for the 2nd, is postponed to the 7th inst.

We have received notice from Captain Davies, the Managing Director of the Exchange Telegraph Company, whose telegrams we print from the electric tapes, that the Company will give daily, at about 4 p.m., the "opening prices" on the New York Stock Exchange of a few of the leading stocks and shares, the rate of exchange, price of gold, and the general tone of the market; as also special extra messages, should circumstances render such necessary. These prices appeared for the first time in our special edition of last evening. In order that these messages should be of value to subscribers, arrangements have been made on the New York Stock Exchange to send them direct to the Company's offices, and not through any news agency, Captain Davies states that the prices hitherto obtained here in the evening are merely the "street prices," but that those supplied by the Company will be those of "the House." One of the directors of the Exchange Telegraph Company has been across to New York to make this and other arrangements for the benefit of the subscribers, and no expense has been spared in order to render them complete. The Managing Director continues:—"Among other things, we are introducing the "Call System," as now worked at New York, by which householders can call a messenger, cab, medical man, police, or give the alarm of fire, and, so soon as the system is worked out, it will be started in the metropolis; in the meantime, we are giving it free to our subscribers on the Stock Exchange for the purpose of calling members from the House to their offices."—*Echo.*

NEW COMPANY.

Allan's Patent Telegraph Cable Company, Limited. Capital £100,000, in £10 shares.—This company is formed for the purpose of purchasing and working a patent having reference to improvements in submarine cables. The subscribers (who take one share each) are—Richard Learmonth, Lavender-hill, Wandsworth; Robert Smith, 32, New Broad-street; George Wood, Regent-street; J. S. Christopher, John-street, Bedford-row; J. F. Lackersten, 3, Lombard-court; Charles Trotter, Park-road, Regent's-park; and P. Ramsay, Nelson-square, Blackfriars.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Dec. 31.
Stock	Anglo-American (Limited)	100	82—82½
10	Brazilian Submarine	9	3¼—3 dis.
10	Cuba	All	7¾—8¼
10	Direct Spanish	9	1 dis.—par
20	Direct United States Cable	14	6½—6 dis.
10	Eastern (Limited)	All	8⅛—8⅜
10	Do., New	All	..—..
10	Eastern Extn. Australia and China	All	8⅛—8⅜
10	Globe Telegraph and Trust	All	7⅝—8⅛
10	Do., 6 per cent Pref.	All	9⅜—9½
10	Great Northern	All	9½—10
25	Indo-European	All	16½—17½
10	Mediterranean Extension (Limited)	All	4¼—4¾
10	Do., 8 per cent Pref.	All	11½—12½
10	Panama and South Pacific	2½	..—.. dis.
8	Reuter's	All	10¾—11¼
Stock	Submarine	100	235—245
1	Do., Scrip	All	2¼—2¾
10	West India and Panama	All	5¼—5¾
10	Do., 10 per cent Pref.	All	9¾—10
20	Western and Brazilian (Limited)	All	12—13
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	100—102
10	Hooper's Telegraph Works	All	12¾—13¼
50	India-Rubber and Gutta Percha	All	27—29
Cert.	Submarine Cables Trust	100	110—112
12	Telegraph Construction	All	31½—31¾
100	Ditto Ditto 7 per cent Bonds	All	103—106

Patents.

786. W. Grigg, of Tamerton Foliott, Devonshire. *The Application of Electricity to Horses and Cattle Suffering from Local, Chronic, and Constitutional Ailments and Diseases, with all Necessary Appendages for applying the same.* Dated March 5, 1873. The invention consists in applying electricity for the treatment of horses and cattle suffering from any disease whatever, by fastening on different parts of the animal certain metal pieces, which are connected to a machine generating electricity, one or more of the metal pieces acting as positive, and others as negative, thus sending a current of electricity through the animal, and thereby producing beneficial effects. This is also done in a variety of ways, such as having metal pieces connected to the horse as positive, and metal flooring as negative, the current passing through the horse down its legs to the metal floor; or by placing the animal under treatment in water and passing electricity through the animal by suitable connections. This invention also consists in using metal pieces of any shape or size required, sponges, or any other means, so that electricity is conveyed by them and applied by their means.

930. J. R. Francis, of Swansea, Glamorgan. A communication from F. A. H. La Rue, of Quebec, Canada. *Improvements in the Process and Machinery for Separating Magnetic from Non-Magnetic Substances, and especially Magnetic Oxide of Iron from all Foreign Material.* Dated March 14, 1873. The process and machinery consists in spreading by a hopper the material to be operated upon (magnetic iron sand or finely pulverised iron ore or similar magnetic substances) upon an endless brattice having spaces formed in it at regular intervals, and acting upon this material by a series of magnets placed side by side and extending above and over the entire width of the brattice. These magnets withdraw and separate the magnetic material from the foreign material on the brattice, and draw it against a cloth stretched under the magnets, such cloth or other suitable material being incapable of interrupting the attraction of the magnets when in contact therewith. The use of the cloth is to discharge the attracted material at regular intervals through spaces formed in the brattice into a suitable receptacle. There is a valve for regulating the supply of material from the hopper to the brattice, and this valve and the frame for the cloth is actuated at the proper times by cam projections on the brattice. Several sets of magnets may be arranged to operate in succession on the same layer of material upon the brattice, which material, after being thus acted upon, is discharged from the brattice as it passes round its forward cylinder.

973. J. G. Tongue, of Southampton Buildings, Chancery Lane, Middlesex. A communication from G. F. Lufbery, of Langlée Works, near Montargis, Loiret, France. *Improvements in Stopping Motions or Apparatus applicable to Knitting and Other Machinery.* Dated March 17, 1873. This invention has for its object mechanical arrangements combined with an electro-magnet for instantaneously stopping certain machines, particularly knitting machines, which require to be stopped quickly under certain circumstances,—for instance when a thread breaks or when the bobbin is run out or other means by which the thread is supplied, when a needle breaks or is out of order, or when the thread is irregular or uneven.

993. J. D. Merriman, of East India Road, Middlesex. *Improvements in Apparatus for Lighting and Extinguishing Public and other Lights.* Dated March 18, 1873.—This invention has reference to the use of electricity for the purpose of lighting and extinguishing public and other lights, and the application of the same consists in placing at the gas office or works a battery which is made to communicate with each lamp. Connected to the service pipe at the top of the lamp-post is a cock furnished with a lever, the end of which is attracted by a magnet and thus opens the cock. The other end of the lever is formed into a fork to hold an arm fixed to a coil spring, which gives motion to a hammer that strikes the nose piece near the burner, when a spark is emitted and the gas lighted. When the gas light is to be extinguished, the magnet is demagnetised, the armature is released, the cock closes, and the gas is shut off, the light being consequently put out.

1000. C. H. O. Hallez D'Arros, of Nancy, Département de la Meurthe (France). *Improvements in Applying Electro-Magnetism to the Production of Locomotion, and Apparatus connected therewith.* Dated March 18, 1873.—This invention relates to means of causing a wheel to run along a smooth iron rail by the force exerted by electro-magnets mounted on the wheel attracting them successively to the rail, which serves as a permanent armature to them. The magnets are arranged radially round the axle with their poles passing through the tyre of the wheel to its outer surface or tread. By the rotation of the wheel the coils on the magnets are brought successively into electrical connection with a battery or other source of electrical power on the carriage, so that each magnet in its turn is rendered active as it is approaching the rail and ceases to act when its pole passes the central or lowest position. The attraction of the successive magnets to the rail produces a series of impulses, which cause the wheel to roll along the rail. When there are two wheels on one axle, the magnets of the one are preferably arranged so as to interspace with those on the other wheel. The battery or source of electrical power may be stationary, and the electricity may be conveyed by conductors laid along the rails, or by the rails themselves. A single electro-magnetic wheel balanced may be made to run along one rail or wire rope for the conveyance of despatches.

1012. A. Jaynor, of Regent's Park, Middlesex. *Improvements in the Construction of Automatic Telegraphs to be Worked by Air, Steam, or Gas.* March 19, 1873.—The novelty of this invention consists in constructing automatic telegraphs in a more simple manner than that described in former specification, 3735, December 9, 1872.

1067. I. L. Pulvermacher, of Regent Street, Middlesex. *Improved Means of and Appliances for the Application of Magnetism in Connection with Electricity for Curative Purposes.* March 21, 1873.—Magnetised spring steel in the form of bands connected by wires from a battery are used to apply magneto-electric currents to the human body. Special methods are described.

1178. Henry Highton, M.A., of Putney, Surrey. *Improvements in Electric Telegraphs, part of which Improvements are Applicable to the Construction of Induction Coils.* March 29, 1873.—The object of this invention is mainly to increase, by the use of an induction coil of peculiar construction, the current acting on the relay or receiving instrument of electric telegraphs.

1180. J. H. Johnson, of Middlesex. *Improvements in Magnets.* (A communication from Hippolyte Fontaine, of Paris, France.) March 31, 1873.—This invention consists essentially in constructing magnets from a number of thin flexible blades united together in the form of a bundle in lieu of using rigid bars as heretofore; also in making such improved magnets of steel wires united in the form of a bundle and held together by polar pieces of soft iron or by non-magnetic metal ties or bands, whereby a considerable increase of magnetism may be concentrated in a comparatively small quantity of steel.

1188. W. Spence, Middlesex. *Improvements in Electric Telegraphs.* (A communication from Francois Félix Girarbon, of Paris, France). March 31, 1873.

1277. T. Fearn, of Birmingham, Warwick. *Improvements in the Electro-Deposition of Tin.* April 7, 1873.—(See page 43).

1508. T. A. Edison, of Newark, in the state of New Jersey, U. S. A. *Improvements in Electric Telegraphs.* Dated April 25, 1873.—My invention relates to the discovery of a method of neutralising the effects of the static charge in any length of line or cable by balancing the electric forces, and the discovery of a point of no electric tension or zero as regards the static charge, so that the receiving instrument when located at that point will be operated by the rise of tension produced by a pulsation that is connected at each receiving instrument and made as instantly and definitely operative as the pulsation given at the transmitting station.

UNITED STATES.

141,387. David Rousseau, New York. *Electric Railway Signal.* Dated February 17, 1873. Signal rotated by weight controlled by electro-magnet. Two circuits to magnet form different points closed by train. Once closed,setting the signal, circuit is shifted by arms on the signal shaft to the other closer, so as to release signal, when circuit is again shifted to setting closer. Lamp guard cannot be opened till weight is wound up.

141,772. Thomas A. Edison, Newark, N.J. *Circuit for Automatic or Chemical Telegraphs.* Dated November 9, 1872. Part of main current shunted through branch circuit. Effect of extra line current neutralised by extra current from local battery, regulated by rheostat.

141,773. Thomas A. Edison, Newark, N.J. *Circuit for Automatic Telegraphs.* Dated January 15, 1873. Line kept statically charged by the main battery, whose circuit is made and broken with immense rapidity by a pulsator, resistance being such that these currents do not affect receiver; transmitter in shunt around the resistance. Receiver has two or more pens in circuits having shunts containing magnets of varying size. Water resistance used to divide current passing to a looped-in station.

141,774. Thomas A. Edison, Newark, N.J. *Chemical Telegraph.* Dated March 13, 1873. Paper wet by chemical solution, by syphon just before reaching electrodes, which are both upon the surface of the paper; current passing across instead of through it.

141,775. Thomas A. Edison, Newark, N. J. *Perforator for Automatic Telegraphs.* Dated March 13, 1873. Each punch actuated by an electro-magnet. Key closes circuit to electro-magnets necessary to perforate any character at once.

141,776. Thomas A. Edison, Newark, N. J. *Circuit for Automatic Telegraphs.* Dated January 15, 1873. The use of an opposition or secondary battery of weak power at one or more points, to act in the main line in opposition to the pulsations from the transmitting instrument, to free the main line of surplus or static electricity.

141,777. Thomas A. Edison, Newark, N. J. *Relay Magnet.* Dated March 13, 1873. Relay contact points close circuit in a liquid. As these points are withdrawn an increasing tension is thrown in circuit by resistance of liquid, thus avoiding spark and oxidation. The adjustable contact points acting within a liquid, in combination with the helix, armature, and spring of a sounder or relay.

141,898. Albert Storer, Cleveland, Ohio. *Electric Annunciator.* April 7, 1873.—An armature concealing a number is centrally pivoted between poles of magnet, and is attracted thereby on closure of circuit, swinging from a vertical to a horizontal position. In so swinging the armature closes a local circuit, locking itself into position. Breaking this circuit restores armature to position, thus avoiding need of special devices.

141,966. Henry Van Hoevenbergh, Brooklyn, New York. *Telegraph Sounder.* May 9, 1873.—Loose core pivoted at one end to bow plays at other end between end of bow and stop.

142,082. Joseph L. Chapman, Philadelphia, Pa. *Telegraph Pole.* March 1, 1873.—Four uprights of angle iron are secured in the ground to a bed-plate. Said uprights incline inwardly towards their tops, where they clamp the cross bars, and are united to each other by horizontal tie rods, which also form a means for climbing the pole.

142,502. Andrew L. Nolf, New York. *Galvanic Battery.* June 6, 1873.—A tube, provided with a stop cock, enters the bottom of the cell, and is connected with a force pump, for the purpose of injecting air into the cell when thought desirable. The tube may also be used for replenishing or withdrawing the fluid.

142,688. Thomas A. Edison, Newark, N. J. *Electrical Regulator for Transmitting Instruments.* March 13, 1873.—An electro-magnet, contiguous to the revolving pulsator shaft, produces friction thereon by attraction, whenever excited by the completion of a circuit, effected by means of a Watt governor on the shaft, making a metallic contact at a prescribed limit of speed.

Telegraphic Facilities.—The *Civil Service Review* hears that arrangements have been made for publishing from time to time, in the "Postmaster's Edition" of the *Postal Official Circular*, a list of all forthcoming occasions of importance likely to give rise to an increased amount of telegraphing either for the Press or for the public. The information thus furnished will serve a twofold purpose; it will enable the postmasters of the offices immediately concerned to concert beforehand, under the authority of their surveyors, such arrangements as may be necessary for the rapid disposal of the work, and it will enable the postmasters of the towns to which the majority of messages on special occasions are addressed (notably the officers in towns where daily newspapers are published) to make provision beforehand for the receipt and disposal of the exceptional traffic which may be looked for. It is proposed to include in the list not merely forthcoming events of magnitude, such as political meetings, conferences, trials, and agricultural shows, but also those of the less important class, such as fairs, regattas, cricket-matches, boat-races, and the like; as it is believed that, in this way much may be done towards developing the revenue at small cost. In order the more effectually to attain this end, postmasters, clerks-in-charge, and others concerned in the management of telegraph business have been directed to endeavour to obtain early information of all important events about to occur in the towns where their offices are situated, or in the neighbourhood, and to communicate with their surveyors without loss of time, suggesting at the same time any arrangements which may in their opinion tend to promote the object in view.

The revenue for the three quarters of 1873 from April to December will be almost exactly the same as it was in the same period of 1872. Up to the 20th ult. the Exchequer had received £50,265,531 against £50,201,773 last year. The weekly account shows a little more than this, because a sum of £800,000 repaid out of the Telegraph Loan has been credited to revenue, instead of being set apart, as usual, with other repayments of advances made under the Acts of the Exchequer Loan Commissioners and similar statutes. An explanation will, no doubt, be forthcoming of the reason why this sum has been thrown into the revenue. It is evidently not revenue, and it was not, indeed, included in the budget estimate of last spring. Accounting has not been hitherto the strong point of the Telegraphic Department of the Post Office, and if any sensible part of the claims now advanced by the railway companies for their reversionary interests is made good, it will go hard with some of the authorities in St. Martin's-le-Grand. The new Postmaster-General will, no doubt, be prepared for adverse criticism, and he can at least point with satisfaction to the fact that the income from the Telegraphic Service is rapidly increasing. In nine months it has been £850,600 against £575,000. It seems, indeed, possible that the extension of the telegraphic system has had some effect on the proper Post-Office revenue, which has now been almost stationary for two years past, instead of advancing continuously, as it had done previously.—*Times.*

Evolution in Electricity.—Mr. C. T. Blanshard, in a letter to *Nature*, applies the theory of evolution to chemical science, and incidentally gives the following generalisations relating to electricity:—"The more complex," he says, "the chemical constitution of bodies, the worse, generally, do they conduct heat and electricity; so, too, the more highly evolved and massive the atoms, the worse conductors are they as a rule. This applies strictly only to groups, as calcium conducts better than barium or strontium, but silver, though heavier and of greater atomic weight, nearly five times better than calcium. The difference of conducting power between metals and non-metals is very apparent. Where the atomic mass is greater, as the body verges more towards the electro-negative, this loss of conductibility and the high fusing-point is easily accounted for by the mechanics of motion. The heavier atom takes longer to communicate its motion in the one case; or is more difficult to move in the other. Some natural groups of the elements offer good examples of what has just been stated, *e.g.*:—

	Atomic Weight.	Specific gravity.	Solubility of Salts.	Electric conductivity.
Ca ..	40·0	1·5	Maximum.	22·14
Sr ..	87·5	2·5	—	6·71
Ba ..	137·0	4·5	Minimum.	Minimum.

Hydrogen has the greatest conducting power of all gases. To the principle that lighter atoms have greater polarity or chemical affinity, Bunsen has found an exception, that cæsium is heavier and yet more electro-positive than potassium or sodium."

Slough Mechanics' Institution.—A few years back it was established as a rule that the Vice-Presidents of the society should each either deliver a lecture every season or provide a lecturer. In accordance with this arrangement, Mr. Spagnoletti procured the services of Mr. E. T. Rolls, of Southampton, to deliver a lecture at the Institute on Tuesday evening, the subject being, "The Electric Telegraph; its History and Application." Mr. C. E. Spagnoletti presided, and there was a very large audience. After a few appropriate introductory remarks from the Chairman, ably pointing out the important part the electric telegraph plays in the social life of the present day, Mr. Rolls commenced his lecture. He gave a brief but lucid explanation of the various contrivances used for the speedy communication of information from a distance, from the earliest times up to the discovery of galvanism by Galvani and Volta, and its practical application by Wheatstone. He then gave a history of the principal lines of electric telegraph wires and submarine cables, and explained the apparatus used, and practically illustrated the working of the same. He explained the important services the telegraph renders on the various lines of railway, as illustrated by what is termed the "block system," and incidentally explained the ingenious apparatus invented by the chairman (Mr. Spagnoletti) for the use of signalmen, showing when the line is clear or when a train is on the line. The various instruments invented by Morse and others for the automatic recording of messages were described, and the principle upon which they worked explained and practically shown. The language of the lecturer was clear, terse, and devoid of technicalities; and the amusing anecdotes related, and original flashes of wit, kept alive the unwearied attention of all present. A very complete and valuable collection of apparatus had been provided for the illustrative experiments, and a wire had been connected with the wires on the Great Western Railway, and brought into the room, by means of which a message was sent to Worcester, and an answer received. At the conclusion of the lecture, Mr. L. Œ. Shadwell proposed a cordial vote of thanks to Mr. Rolls and to Mr. Spagnoletti, and it was returned in the most hearty manner by the audience. Considering the very general lack of information on all scientific matters, it is to be wished this class of lectures were more popular.